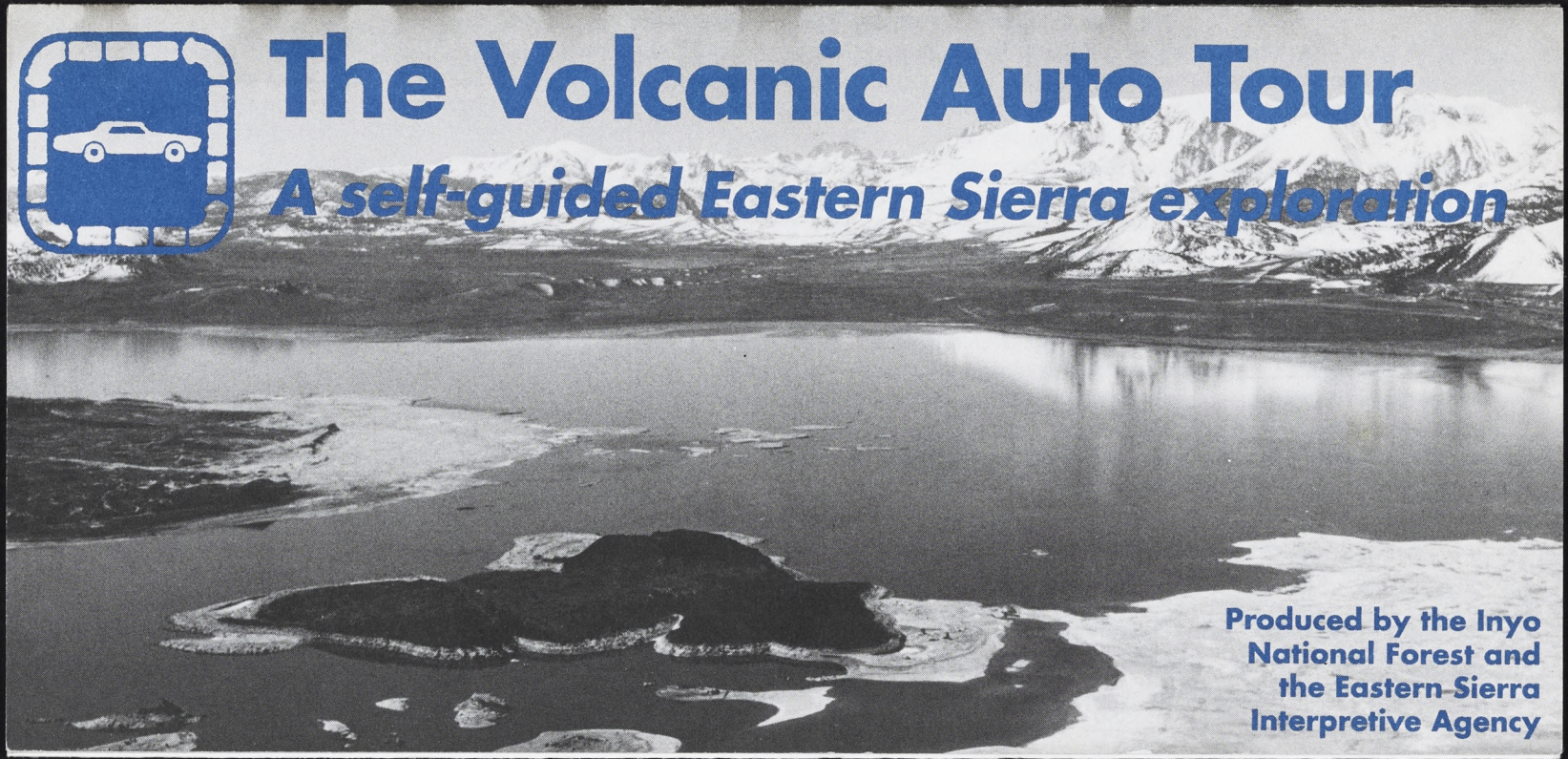
The Volcanic Auto Tour

A self-guided Eastern Sierra exploration



Produced by the Inyo National Forest and the Eastern Sierra Interpretive Agency

The breathtaking scenery you are about to explore is like a book written in a foreign language telling a story as old and as deep as the earth itself. The story is of the tremendous earthquakes and volcanoes which shape and reshape the face of the earth, leaving behind distinctive faults, craters, and cones. In just a few miles, this self-guided tour will introduce you to steaming hot springs, infant lava flows, and volcanic craters, and help you translate these volcanic features—representative of many found on earth—into a complete narrative.

M. Cox

The Volcanic Auto Tour

This tour may be started from Lee Vining or Mammoth Lakes. Directions are given from both locations, and signs marking auto tour stops and turnoffs are posted on both sides of Hwy 395 (see sign logo on cover). Allow three or more hours to enjoy the full tour. Even though the tour follows well-graded roads and is never more than a few miles from Hwy 395, always drive with caution and carry plenty of drinking water. **Please stay on established roads.** Distances between stops are given, but remember that odometers can easily vary by a tenth of a mile or more.

The sites you will visit are classic examples of geologic events, yet there are still other interesting volcanic features throughout the Eastern Sierra. Be sure to visit local bookstores, the Mammoth Ranger Station, Lee Vining Ranger Station, Mono Lake Committee Information Center, or the National Forest Scenic Area Visitor Center for more detailed information.

Northbound travel, starting from Mammoth Lakes or the Mammoth Ranger Station: Drive east on Hwy 203 to the broad pullout area just before the Hwy 395 overpass. Start the tour with number 1, working to number 12. • **Southbound travel, starting from Lee Vining:** Drive north on Hwy 395 two miles to the Old Mono Marina (Picnicground Rd.) and start the tour with number 12, working to number 1.

1. Mammoth Mountain Vista

Stop at the pullout on route 203 just east of the Hwy 395 overpass.
Northbound: *First stop* • ***Southbound:*** *return to Hwy 395 and travel 3.0 miles north to Mammoth Lakes exit. This is your last stop. Keep an eye out for the numerous other volcanic features of the Eastern Sierra as you continue your travels!*

At your location, you are partway into the Long Valley Caldera. Erupting about 700,000 years ago, the caldera's violent eruption would have made the Mountain St. Helens eruption seem a gentle burp. The powerful explosion sent gases and clouds of glowing ash as far east as Nebraska (possibly as far as the Atlantic Coast) and blanketed the sites along our tour. Geologists believe the eruption partially emptied an underground **magma** (hot, liquid lava) chamber, allowing the ground surface above the chamber to collapse and create a large sunken hole called a **caldera**. Long Valley Caldera is about 15 miles wide by 20 miles long, extending from Crowley Lake to the Crestview grade and from the slopes of Mammoth Mountain to Glass Mountain (see map).

You can identify Mammoth Mountain by the ski slopes and lift structures on the horizon. Although well-known as a ski resort, few people realize that Mammoth is a quiescent (dormant) volcano which underwent a series of eruptions that formed the rim of the Long Valley Caldera 250,000 to 50,000 years ago. Its volcanic history is told by ash layers and lava flows which have been sculpted by wind, snow, ice, and humans.

2. Hot Creek Fish Hatchery

Stop at the fish hatchery buldings.
Northbound: *take Hwy 395 south for 3.0 miles and exit at Hot Creek Hatchery. Travel a short distance east from the turn-off, then turn right onto Hot Creek Hatchery Rd., follow signs to paved parking area* • ***Southbound:*** *backtrack 2.3 miles on the dirt road to the hatchery*

A chamber of hot, molten magma remains deep beneath the earth's surface here with channels of water circulating among the layers of rock overlaying the magma. The water picks up heat as it comes in contact with the heated rocks in a process called **geothermal heating**. At the hatchery, springs of this geothermally heated water rise naturally to the surface. Water from the four different springs mixes with the cold water of Mammoth Creek to create ponds ranging in temperature from 52 to 62 °F. The year-round constant temperature of the ponds creates an ideal environment for incubating trout eggs and raising fish. Hot Creek Hatchery was built in the early 1930s and is operated by the California Department of Fish and Game. It is open to the public daily from 8-4 during the summer season.

3. Hot Creek Geologic Site

Stop at the paved aprking area wth interpretive signs.
Northbound: *Continue down the main dirt road 2.3 miles, following signs* • ***Southbound:*** *return to Hwy 395, travel south for 3.0 miles and exit at Hot Creek Hatchery. Travel a short distance east from the turn-off, then turn right onto Hot Creek Hatchery Rd., follow signs to hatchery.*

Looking into the Hot Creek gorge from the edge of the parking area, you will see two typical geothermal features: boiling hot springs and **fumaroles** (steam vents). You may also notice the odor of rotten eggs caused by sulphur dioxide escaping from the steam vents. Why are the pools blue? It is an optical illusion caused by light reflecting from white calcium carbonate crystals in the rock. The boiling hot springs and the steaming fumaroles are obvious indications that this region is still very geologically active and, in fact, earthquakes and underground magma activity may change the location or intensity of these hot springs and fumaroles overnight. **Use extreme caution in this area.**

M. Cox

4. Casa Diablo Geothermal Power Plant

From Mammoth Lakes exit, turn east, drive .4 mile and pull over where road curves sharply to the right.
Northbound: *return to Hwy 395 and drive north 3.0 miles to exit* • ***Southbound:*** *return to southbound lanes by making a U-turn just north of stop 5, continue south on Hwy 395 for 3.7 miles to exit.*

About 600 feet beneath you, the Mammoth-Pacific Geothermal Power Plant taps into a reservoir of geothermally heated water. The 340 °F water is pumped through heat exchangers and converted to electricity at the plant in front of you. The facility produces 8,000 kilowatts of electricity—an amount that meets one-third of Mammoth Lakes' summer demand for power.

5. Smokey Bear Flat

Stop at the wide turnout wide turn out next to a large sandflat.
Northbound: *return to Hwy 395 and drive north 3.2 miles* • ***Southbound:*** *return to Hwy 395, travel south 2.0 miles, make a U-turn to large turnout on east side of highway.*

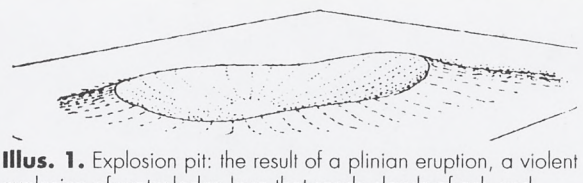
Walk beyond the sagebrush surrounding the turnout into the flat of gravel-sized rocks. Take a moment to sort a few rocks into piles by color, texture, and weight. Here, the lightest color is usually the lightest in weight. This rock is **pumice**, a lightweight, porous rhyolitic (rye-o-li-tic) rock from an explosive volcanic eruption. Pumice is sent flying into the air by the force of the explosion and may be carried by the wind. Larger and heavier particles land closer to the source of eruption while small ash and rock travel farther. The Smokey Bear Flat pumice probably originated in the Inyo Craters eruption 500-600 years ago. Small plants such as pink and yellow monkeyflowers often carpet pumice flats in the spring, but neither trees nor sagebrush will grow in these flats. Why not? Perhaps the pumice lacks essential nutrients. Perhaps there is not enough water or the water is too deep for the plants to reach. Scientists are not sure. What do you think?

6. Lookout Mountain

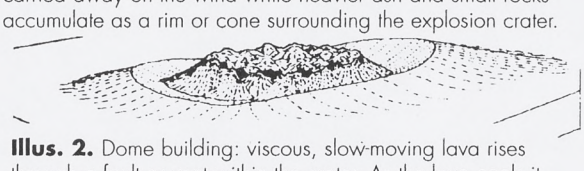
On Lookout Mountain Road, head east, bear right at .9 miles and continue another 2.1 miles to mountaintop following main dirt road and noting signs; not recommended for buses or motorhomes.
Northbound: *Continue north 2.1 miles, make right turn opposite the Scenic Loop road* • ***Southbound:*** *return to Hwy 395 and travel south 6.0 miles, turn left at Scenic Loop junction and cross northbound lanes.*

A rough road leads to an eagle's view of the Long Valley Caldera and other volcanic features you are visiting on the ground. At the top of Lookout Mountain you are standing on one of the many resurgent domes (see ill. 2) uplifted after the collapse of the caldera. Look for Crowley Lake, 18 miles to the south; Mammoth Mountain, 8 miles to the southwest; and Glass Mountain (the long ridge beginning with Bald Mountain Fire Lookout), 14 miles to the southeast. These landmarks form the edges of the caldera. For comparison, the caldera left behind from the 1980 Mount St. Helens eruption was about one mile in diameter.

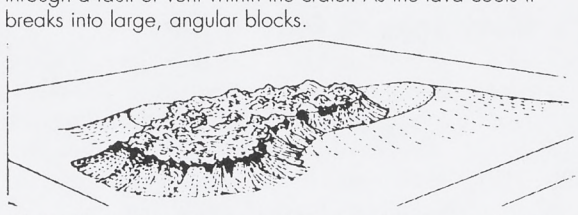
At your feet you will find both pumice and obsidian. Although they look very different, these two rocks are chemically the same. Imagine a bottle of soda or mineral water. When you look at the sealed bottle you see a liquid of uniform consistency. Now if you shake the bottle and remove the cap, the pressure is released. Gas bubbles form which may shoot off in an "explosion" while the liquid oozes over the rim. A rhyolitic explosion is a similar process. Pressure on the magma is reduced as the magma rises to the earth's surface. Some of the molten material expands and explodes, forming pumice (soda bubbles), while some retains its original texture and cools into glassy fragments called obsidian (liquid soda). Adventurers may wish to visit the Inyo Craters, Earthquake Fault, and Devils Postpile by traveling west on the Scenic Loop Road.



Illus. 1. Explosion pit: the result of a plinian eruption, a violent explosion of water-laden lava that sends clouds of ash and small rocks miles into the air. The lightest particles of ash are carried away on the wind while heavier ash and small rocks accumulate as a rim or cone surrounding the explosion crater.



Illus. 2. Dome building: viscous, slow-moving lava rises through a fault or vent within the crater. As the lava cools it breaks into large, angular blocks.



Illus. 3. Coulee: pressure builds inside the magma chamber causing more lava to rise within the crater. This lava extrusion runs over and through the rim surrounding the original crater and dome, appearing as a short, thick flow of large volcanic blocks.

W. C. Putnam

7. Obsidian Dome

Travel west on Glass Flow Road 1.4 miles to parking lot with interpretive sign.
Northbound: *return to Hwy 395 and travel 5.4 miles north to turnoff* • ***Southbound:*** *return to Hwy 395 and travel 3.2 miles south to turnoff.*

To understand how obsidian is extruded from the earth, imagine holding a tube of toothpaste upright and slowly squeezing the tube. The thick, viscous material forms a column which will fall quickly for lack of solid support. Now go a step farther and imagine that instead of toothpaste, your tube is full of melted glass (like obsidian). When the column of glass comes into contact with air, the outside cools and stops moving. The inside of the column keeps moving because it is still under pressure. What do you think might happen? The outside surface becomes a brittle skin that cracks and falls away. Imagine the obsidian column oozing from the earth, cooling, and braking off.

Native Americans gathered obsidian from sites like this, working the glassy stone to make cutting tools such as points, scrapers, and knives. Tools from Eastern Sierra sites have been found throughout North America, suggesting obsidian was a valuable trade item. Obsidian is still the sharpest cutting material known. **Please leave what you see for others to enjoy. Remember: Federal law prohibits artifact collecting.**

8. Devil's Punchbowl

Travel east on Pumice Mine Rd 1.7 miles, watching for trucks. Drive .1 mile (or hike if road is too sandy) on spur road at left.
Northbound: *return to Hwy 395, travel 3.2 miles north to turnoff* • ***Southbound:*** *continue straight on West Portal Road 1.4 miles, then turn right at split in main road near powerpoles, drive to highway and cross northbound lanes, continue .5 mile to southbound lanes and drive 4.5 miles south to turnoff.*

The Devil's Punchbowl is a small crater or explosion pit formed by an explosive, rhyolitic eruption. Do you recognize the gravel-sized pumice thrown out by the violent event? This type of eruption is called **phreatic** (free-ah'-tic), meaning the magma passed through the underground water table as it rose, heating the water and adding steam to the eruption. Gravel-sized particles fell close to the source of the explosion creating the rim where you stand, while the lighter fragments and ashes were blown further away. The small dome inside the crater was built after the phreatic eruption.

9. Mono Craters Vista

Mono Craters vantage point.
Northbound: *return to Hwy 395 and travel 2.7 miles north to scenic overlook turnoff; this is also the location of the next stop* • ***Southbound:*** *same location as stop number 10.*

The eerie landscape before you is the 10-mile-long chain of abutting and overlapping domes and coulees which have been misnamed the Mono Craters. They are not craters and here's why: The first stage of a rhyolitic

(Over, please)

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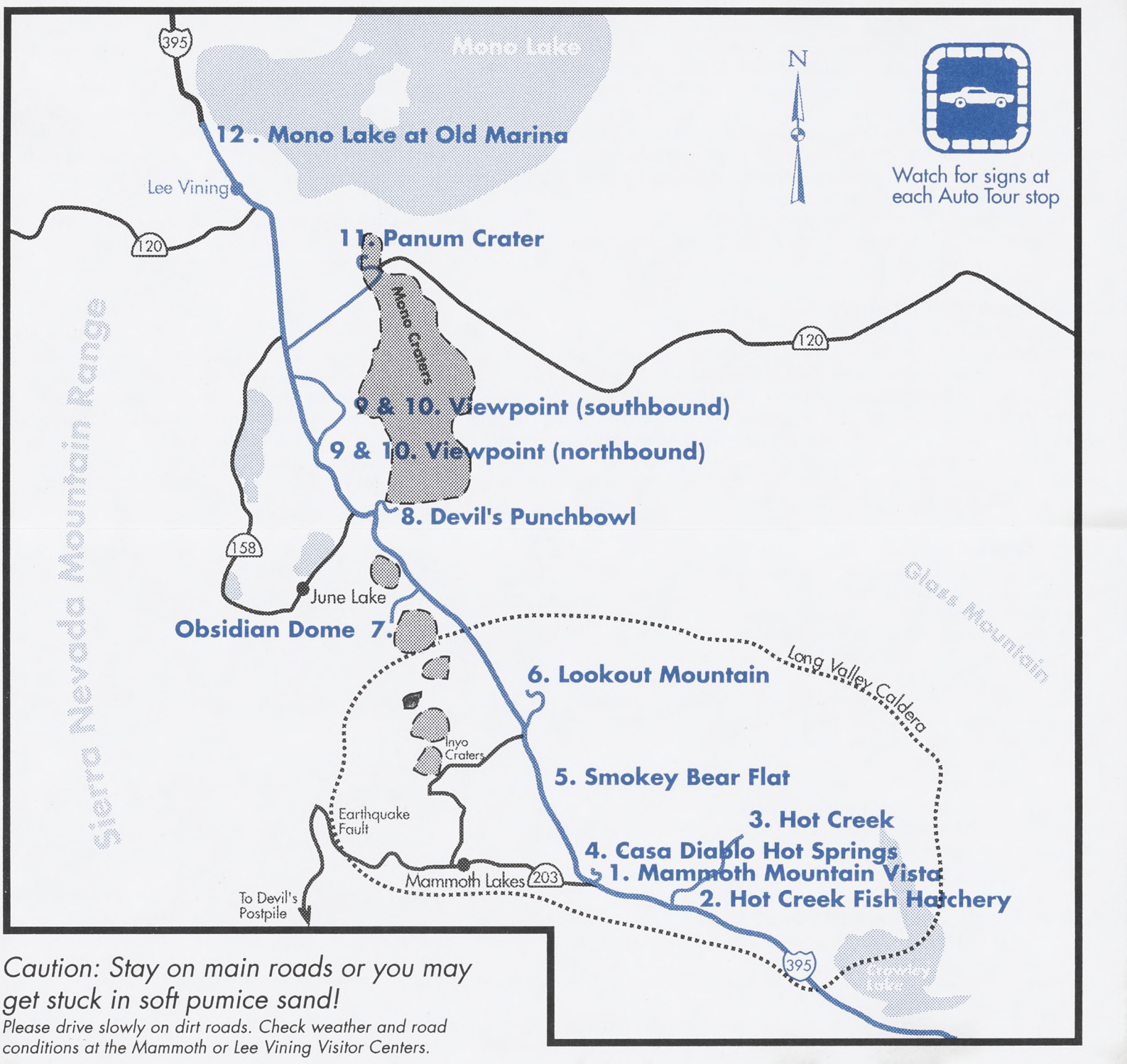


Caution: Stay on main roads or you may get stuck in soft pumice sand!

Please drive slowly on dirt roads. Check weather and road conditions at the Mammoth or Lee Vining Visitor Centers.

(Stop 9, continued)

eruption is phreatic (ill. 1), leaving a pit or crater. The fine-grained, light colored rock at your feet and covering the "Craters" is rock blown by the eruption. Lava then began to rise, creating domes and coulees typical of rhyolitic eruptions (ills. 2&3). Eruptions in the Mono Craters began at least 40,000 years ago and continued until recently, with the last eruption about 600 years ago at Panum Crater. In the 1930s, the Los Angeles Department of Water and Power began constructing an 11-mile long aqueduct tunnel in the southern region of the Mono Craters. Workers encountered large volumes of hot and cold water, steam, and carbon dioxide, indicating this area is still very active.

The Mono Craters are mined for pumice blocks (the only operation of its kind in the United States). These blocks are used for restaurant grill cleaners and landscaping stone, and pumice pebbles are used to create stonewashed jeans. If you see a pumice product marked "US Pumice," it originated in the Mono Craters.

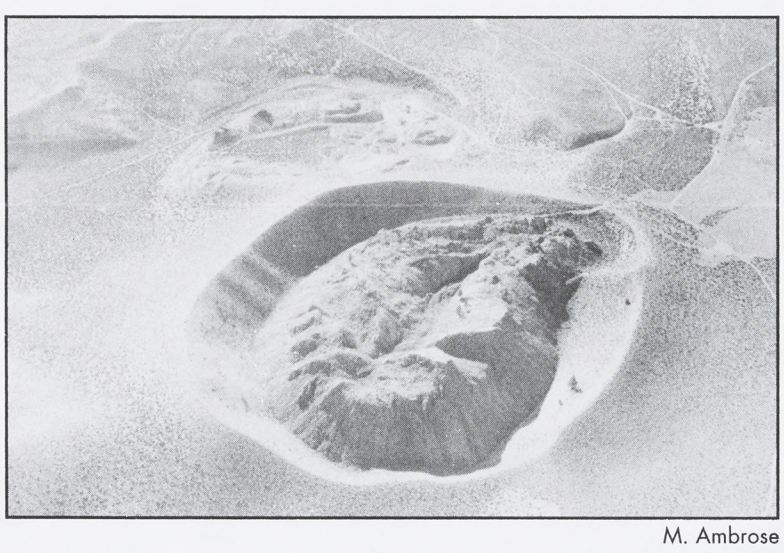
10. Aeolian Buttes

Mono Craters vantage point.

Northbound: *Same location as stop 9* • ***Southbound:*** *return to Hwy 395, drive 1.6 miles south and turn left onto West Portal Road. Cross the northbound lanes and continue .9 miles on dirt road, stop when road curves south and provides good view of the Mono Craters; this is also the location of the next stop.*

The pink colored Aeolian Buttes are a result of the immense explosion that created the Long Valley Caldera, 700,000 years ago. Fiery clouds of ash spread north from the Long Valley area and compacted into a blanket of pink, relatively soft rock called **Bishop tuff**. Later, volcanic and glacial activity deposited ash, rock, and debris on top of the tuff. In places, wind and rain later eroded the deposition, exposing the tuff.

Wander among the rocks looking for crystals, lenses of obsidian called fiami (fee-ah'-mee), and signs of wind and water erosion. How does this rock compare to rocks you've seen elsewhere? Can you tell the difference between the soft tuff and harder granite (the rock normally found in the High Sierra)?



M. Ambrose

11. Panum Crater

Travel east 3.3 miles on Hwy 120 to Panum Crater sign, turn north (left) down a dirt road to kiosk.

Northbound: *return to highway, travel 3.5 miles north to Hwy 120*

Southbound: *return to highway, travel south 7.3 miles to Hwy 120.*

Panum Crater is a rhyolitic volcano and you are outside its rim. Listen carefully as you make the short walk to the exhibit shelter. Do you recognize the sound of grinding glass fragments underfoot? The chemistry of rhyolite is about 75% silica, the raw material of glass. Look at the rocks at your feet. What does their size tell you about the source of the eruption? Dig down a little. Does the size change? Panum is one of the youngest volcanoes in the Eastern Sierra, erupting about 600 years ago. Its eruption followed the pattern of the Mono Craters, Devil's Punchbowl, and Mount St. Helens. Trails on the rim (1 hour) and interior (1 hour) of Panum let you explore the plug dome volcano more fully.

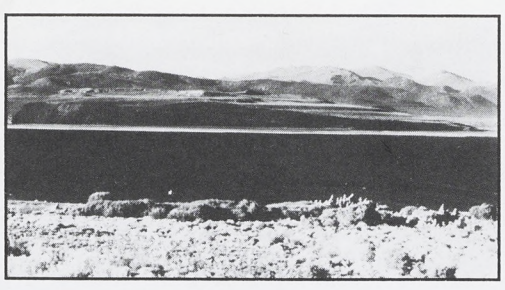
12. Mono Lake at Old Marina

Travel 1.5 miles north of Lee Vining, turn right on Picnicground Rd. (paved), park near kiosk.

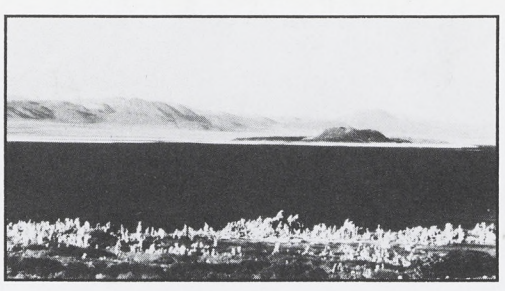
Northbound: *return to highway and travel 7.1 miles north. This is your last stop. Keep an eye out for the numerous other volcanic features of the Eastern Sierra as you continue your travels!* • ***Southbound:*** *First stop.*

Mono Lake, one of the oldest lakes in North America, is surrounded by volcanoes that erupted as much as 13 million years ago. The Bodie Hills, Anchorite Hills, and Cowtrack Mountains form the far horizons to the northeast and east, and they are far older than the 700,000-year-old lake. A short boardwalk located about 1/4 mile southeast from the paved lot (bear right at kiosk) takes you to the shore where you will find pumice boulders encrusted with tufa (too'-fuh). Thousands of feet of volcanic ash, deposited in the lake over the centuries, help make Mono Lake water extremely alkaline. Be sure to feel the water; does it feel slippery or soapy to you?

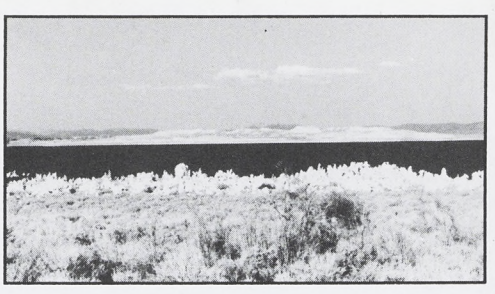
The photos below identify three key volcanic Mono Lake features. Additional information about Mono Lake ecology and tufa can be found at the interpretive kiosk in this parking area, at the Mono Basin Scenic Area Visitor Center, or the Mono Lake Committee Information Center and Bookstore.



On the near horizon, the oldest visible volcano is **Black Point**. This **basaltic** (ba-sal'-tic) volcano (rock similar to the Hawaiian volcanoes) erupted underwater 13,000 years ago, when Mono Lake was much deeper. Unlike most basalt, Black Point's flow was squelched by the relatively cool lakewater. This caused the lava to fracture into ash and pea-sized rock fragments called lapilli (la-pill'-ee). Lapilli, also called cinders, are mined from Black Point and used on icy highways in Mono County to improve tire traction and hasten snow melt.



The dark, cone-like island in Mono Lake is **Negit Island**, another basaltic volcano. Negit (Ne'-git) first erupted about 2,000 years ago—a few seconds ago in geologic time. Repeated extrusions (flows) created the craters and cone that you see. The most recent activity on Negit was about 220 years ago. While our founding fathers were signing the Constitution, volcanoes were erupting at Mono Lake. Negit Island is an important nesting site for tens of thousands of California gulls. Israel Russell, an early geologist, gave the island its name which means "blue winged goose" in the local Kuzedika Paiute language.



Paoha Island, the light-colored island, is composed of fine grained lake-bottom sediments pushed above the lake surface by a magma chamber. Paoha (Pay-oh'-hah) rose, rather than erupted, about the same time as the most recent activity on Negit. Paoha's ridges and cliffs were formed as the sediments slipped lakeward during the islands uplift. The north end of Paoha, not visible from here, shows more common evidence of volcanic origin with cinder cones, lava flows, and fumaroles. Russell also named Paoha following the Native American tradition, describ in "diminutive spirits with long from hot springs."

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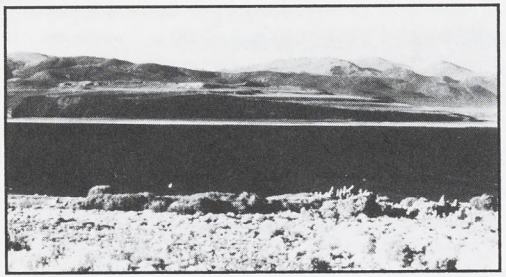
Cover photo by Jim Stroup



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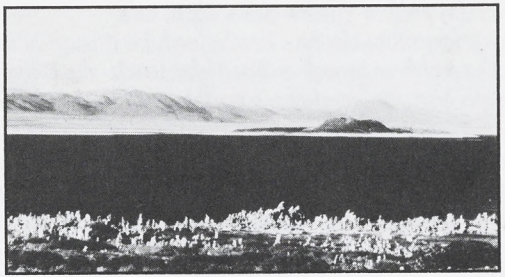

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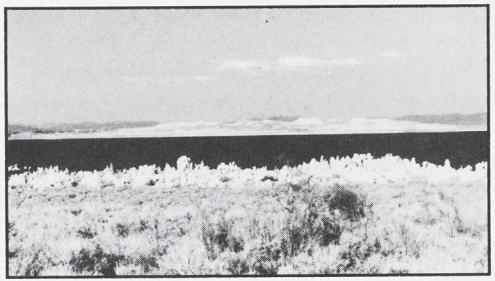

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